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## MEMORANDUM

TO: Janet Spencer, Associate Environmental Research Scientist **HSM-02001**  
Worker Health and Safety Branch

FROM: Sally Powell, Senior Environmental Research Scientist *[original signed by S. Powell]*  
Worker Health and Safety Branch  
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SUBJECT: EQUATIONS FOR PREDICTED VALUES AND PREDICTION LIMITS FOR  
DISLodgeABLE FOLIAR RESIDUES

These are the equations I used to calculate the unbiased predicted values and prediction limits for your methomyl, propargite and phosmet DFR.

The method for calculating the unbiased predicted DFR is standard, although not found in most statistics texts. The method is due to Bradu and Mundlak (1970), and is implemented as described in Powell (1991).

Unbiased predicted DFR = (predicted ln DFR)  $\times g_m(q)$ ,  
where

$$g_m(q) = \sum_{j=0}^{\infty} \frac{m^j (m+2j)}{\prod_{i=0}^j (m+2i)} \frac{q^j}{j!} \left[ \frac{m}{m+1} \right]^j,$$

$$q = \frac{m+1}{2m} \left( s^2 - \hat{\sigma}_{y_h}^2 \right),$$

$s^2$  is the mean squared error from the regression,  $m$  is the number of degrees of freedom associated with  $s^2$ , and

$$\hat{\sigma}_{y_h} = \sqrt{s^2 \left( 1 + \mathbf{x}_h' (\mathbf{X}'\mathbf{X})^{-1} \mathbf{x}_h \right)}$$

is the estimated standard error of prediction for a new observation on Day  $h$ .



A one-sided 95% prediction limit for a given day  $h$  after application =

$$\text{Unbiased predicted DFR} \times \exp \left\{ t_{(0.95; m)} \sigma_{y_h}^{\wedge} \right\}.$$

The calculation of standard errors of prediction and prediction limits are part of standard linear regression analysis, and can be found in many statistical texts, e.g., Neter *et al.* (1985).

- Bradu, D. and Mundlak, Y. 1970. Estimation in lognormal models. *J. of the American Statistical Association* 65:198-211.
- Neter, J., Wasserman, W. and Kutner, M.H. (1985) *Applied Linear Statistical Models: Regression, Analysis of Variance and Experimental Designs*. 2nd/Ed. Richard D. Irwin, Inc., Homewood, Illinois.
- Powell, S. (1991) *Implementation in the SAS System of the Bradu-Mundlak minimum variance unbiased estimator of the mean of a lognormal distribution*. In "Proceedings of the 16th Annual SAS Users Group International Conference", pp. 1745. SAS Institute, Inc., Cary, NC.

cc: Joe Frank